

## 1 INTRODUCTION

The National Renewable Energy Laboratory (NREL) is a U.S. Department of Energy (DOE) national laboratory, and conducts research primarily for DOE's Office of Energy Efficiency and Renewable Energy (EERE). The Midwest Research Institute and Battelle operate NREL under the oversight of the DOE Golden Field Office (GO). NREL is the nation's premier laboratory for renewable energy research and development and a leading laboratory for energy efficiency research, with programs in wind energy, solar energy, plant and waste-derived fuels and chemicals, energy efficiency in buildings, geothermal energy, advanced vehicle design, and hydrogen infrastructure and fuel cells.

### Purpose

This report presents a summary of NREL's environmental protection programs and activities for 2004. It is organized according to the different environmental media (e.g. air, waste, ground water, etc.), and includes a brief summary of how the program is managed in that area, any permitting or notification efforts that have been completed during the reporting period or are ongoing, and activities that have occurred during the reporting period in that environmental area. A description of the environmental condition and features of NREL's sites is also included to provide a basis for the program overview.

This report is organized to present many of the elements of the Global Reporting Initiative (GRI) Sustainability Reporting Guidelines. It also incorporates DOE guidelines for the 2004 Annual Site Environmental Report, as required by DOE Orders 231.1 and 5400.5.

### Background

NREL's mission: NREL develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to the private sector to address the nation's energy and environmental goals.

NREL fulfills its mission through technology portfolios; a brief description of each major technology area follows.

*Photovoltaics:* Photovoltaics is the direct conversion of sunlight to electricity using solid-state materials. The National Center for Photovoltaics develops and deploys photovoltaic (PV) technology for the generation of electric power.

*Wind Energy:* Through the National Wind Technology Center (NWTC), NREL develops, improves, and demonstrates the viability of wind technology for electricity generation and facilitates its deployment throughout the world

*Bioenergy:* NREL currently has major programs in both biomass-derived fuels (biofuels) and biomass-derived electricity (biopower), and projects in biomass-derived chemicals and materials.

*Renewable Thermal Technologies:* These technologies generate power from heat or utilize heat from renewable resources. They include concentrating solar power, solar water heating, and geothermal heat and power.

*Distributed Power:* Distributed power is modular electric generation or storage located near the point of use. NREL participates in the development of technologies, market structures, and policies that affect the incorporation of renewables and energy efficiency technologies in distributed power systems, maximizing the deployment of renewable energy and energy efficiency products. As a part of this initiative, NREL is involved in the development, design, and deployment facilitation of renewable and renewable/fossil hybrid distributed power systems in grid-connected applications.

*Building Energy:* NREL increases the use of energy efficiency technologies and expands the use of renewable energy technologies in the building sector by working to develop new, cost-effective and environmentally acceptable building equipment and envelope systems.

*Hydrogen:* NREL serves as a leader in renewable hydrogen production technologies as well as in advanced storage and sensor development, and codes and standards development. Basic and applied research and material development using biology, physics, and chemistry enable and support the development of hydrogen production, storage, and end-use systems.

*Transportation:* NREL works with industry to develop advanced vehicles and systems for transportation, and to develop viable vehicle systems that are integral to DOE transportation initiatives. NREL also works with energy companies and manufacturers of vehicles and engines to develop advanced motor vehicle fuels for improved energy and environmental performance. A systems approach is used to develop optimized engine management, fuel, and emission control technologies.

*Basic Science:* Fundamental research is conducted in the sciences that underlie NREL's renewable energy and energy efficient technologies.

*Computational Sciences:* This area includes basic and applied research using high-performance computing and applied mathematics.

*Electricity Technologies:* These technologies include renewable energy, hydrogen, and superconductivity technologies, plus utility resources.

*Energy Analysis:* Research at NREL includes energy analysis for various programs and initiatives.

*Measurements and Testing:* NREL labs and facilities allow state-of-the-art testing on photovoltaic cells, building technologies, and wind turbines.

*Renewable Energy Resources:* Researchers develop resource information for solar, wind, biomass, and geothermal energy applications.

### Site and Facility Description

NREL facilities occupy four separate locations in Jefferson County, Colorado, near the city of Denver, and one within the boundaries of the City and County of Denver. The four facilities in Jefferson County include the Denver West Office Park (DWOP), the South Table Mountain site (STM), the Joyce Street Facility (JSF) and the National Wind Technology Center (NWTC). The Renewable Fuels and Lubricants Research Laboratory (ReFUEL) is located within the city limits of Denver. The DWOP and STM sites are approximately 2 miles (3.2 km) east of Golden and 12 miles (19.3 km) west of central Denver. The NWTC is located near the intersection of Highways 93 and 128, between Boulder and Golden, and is approximately 15 miles (24.2 km) north of the STM site. It is adjacent to the DOE Rocky Flats Environmental Technology Site. The JSF is located at 6800 Joyce Street, approximately 5.5 miles (8.9 km) north of the DWOP and STM sites. The ReFUEL Facility is located with the Regional Transportation District (RTD) District Shops and Operation Center (DSOC) located at 1900 31<sup>st</sup> Street, Denver, about 12 miles east of the STM and DWOP sites. Figure 1.1 illustrates the locations of the STM, DWOP, NWTC, and JSF sites on a regional map. The location of the ReFUEL Facility is shown on Figure 1.2. Figure 1.3 provides a more detailed map of the STM site, and Figure 1.4 provides detail for the NWTC site.

The STM and NWTC sites are the two main sites where research operations are conducted. These two sites will be addressed separately in the discussion of environmental features. The DWOP is leased space used primarily for administrative functions and limited research activities. The JSF is also a leased space that is currently used for storage. The ReFUEL Facility is a leased facility that consists of a small shop complex housed within the RTD/DSOC facility. NREL performs engine-testing activities pertaining to fuels and lubricants at the site.

Figure 1.1 – Regional Map

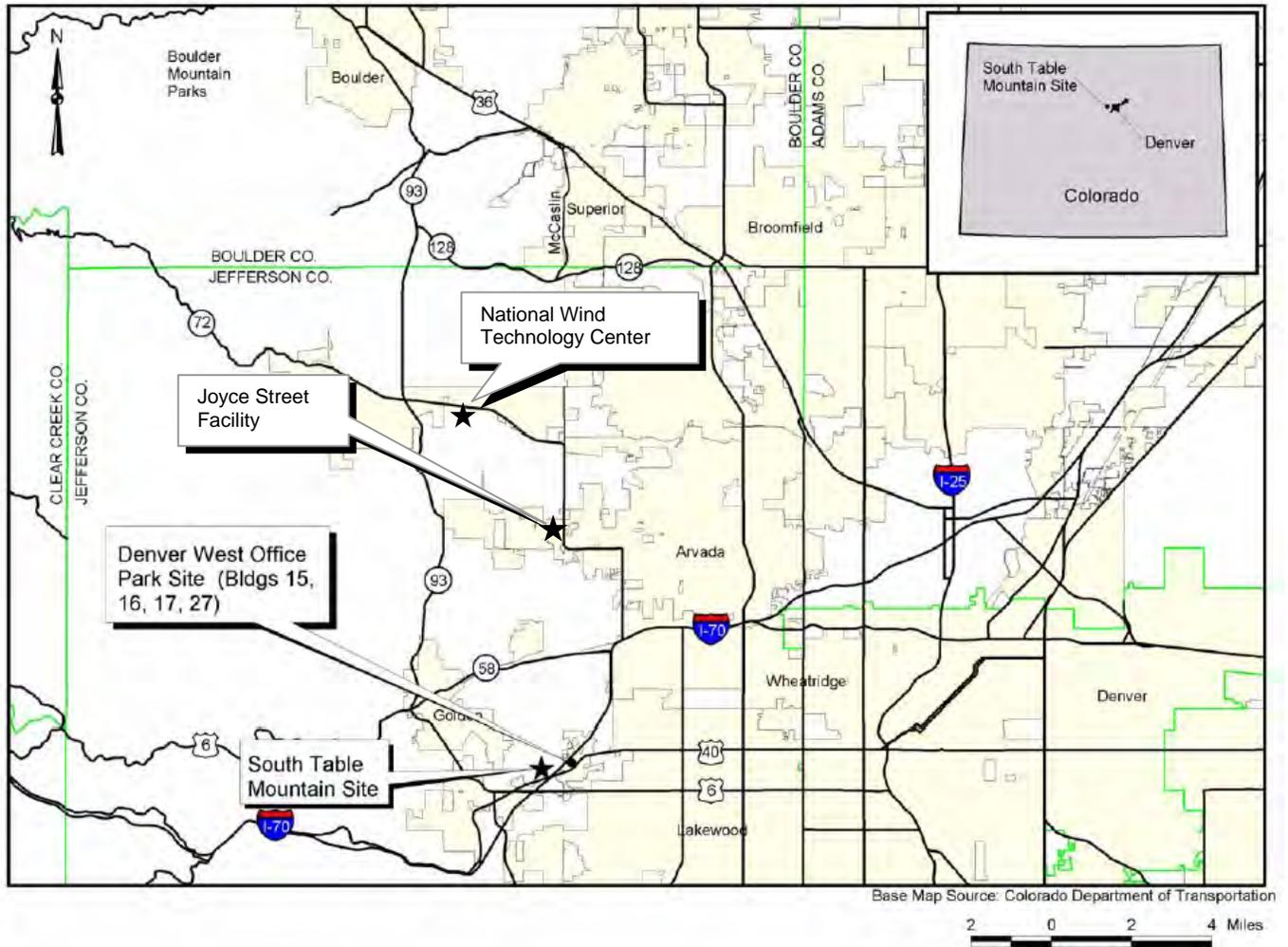


Figure 1.2 – ReFUEL Facility Location Map

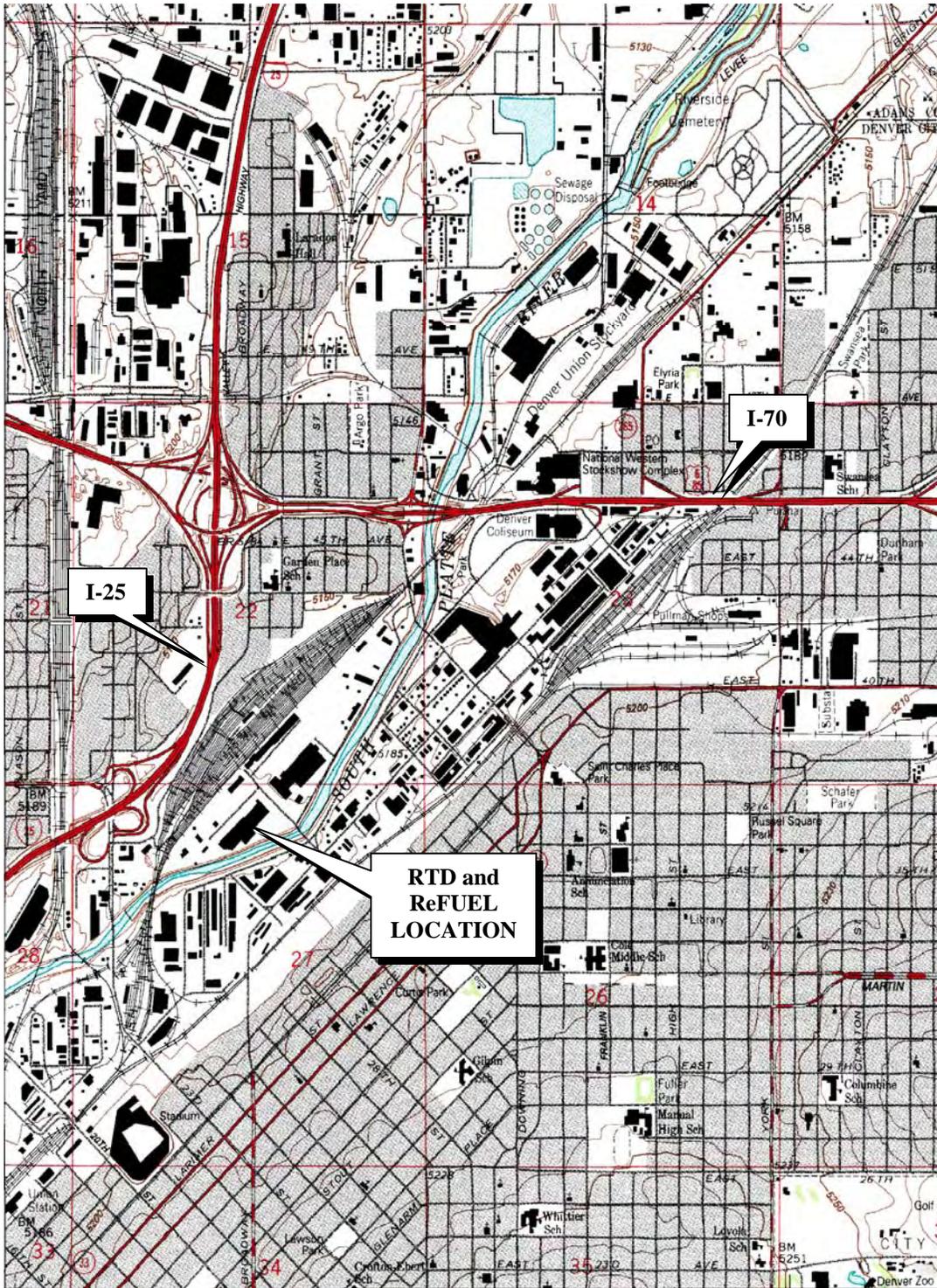


Figure 1.3 – STM Site Map

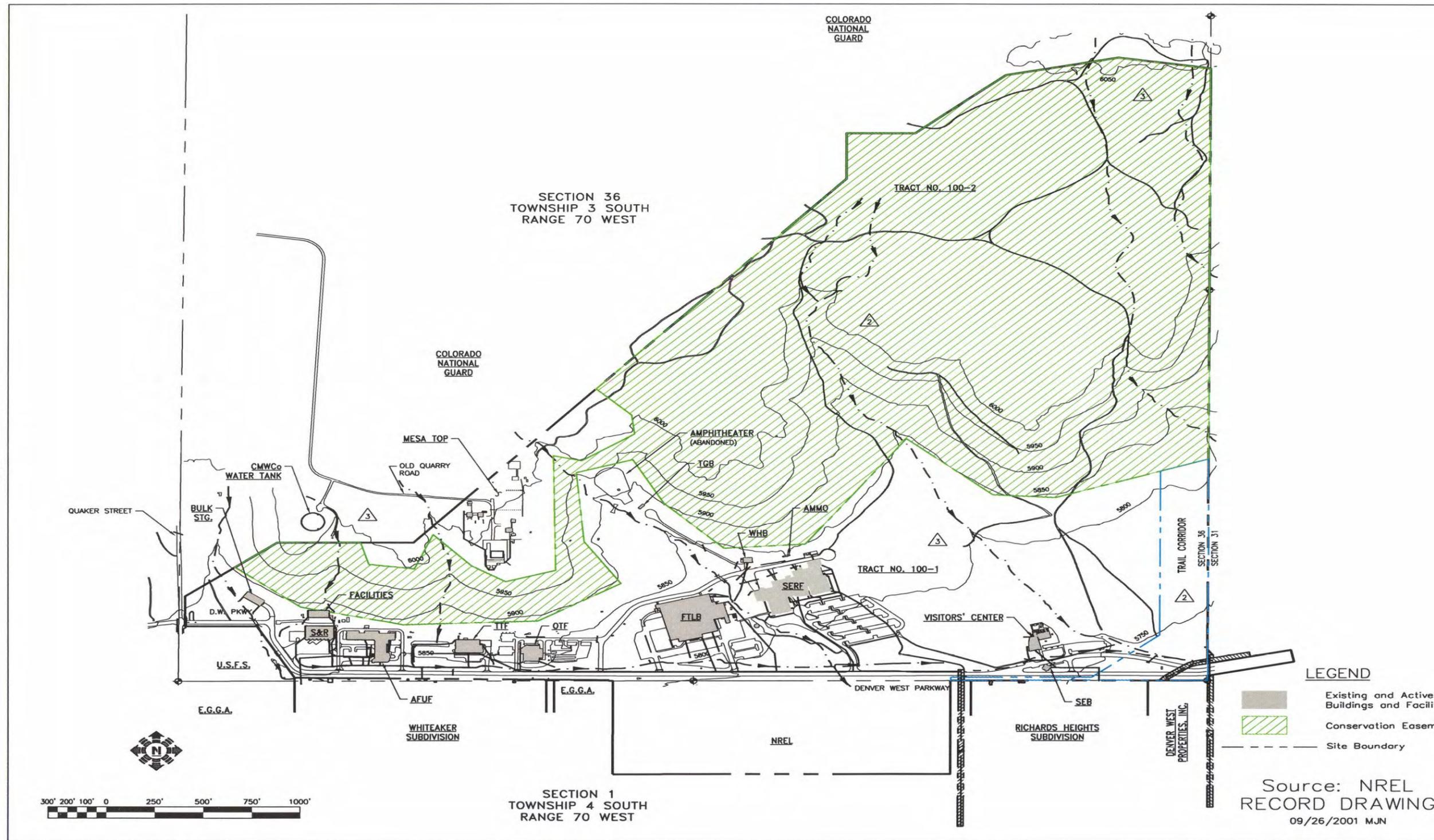


Figure 1-3 South Table Mountain Site Map

Figure 1.4 – NWTC Site Map

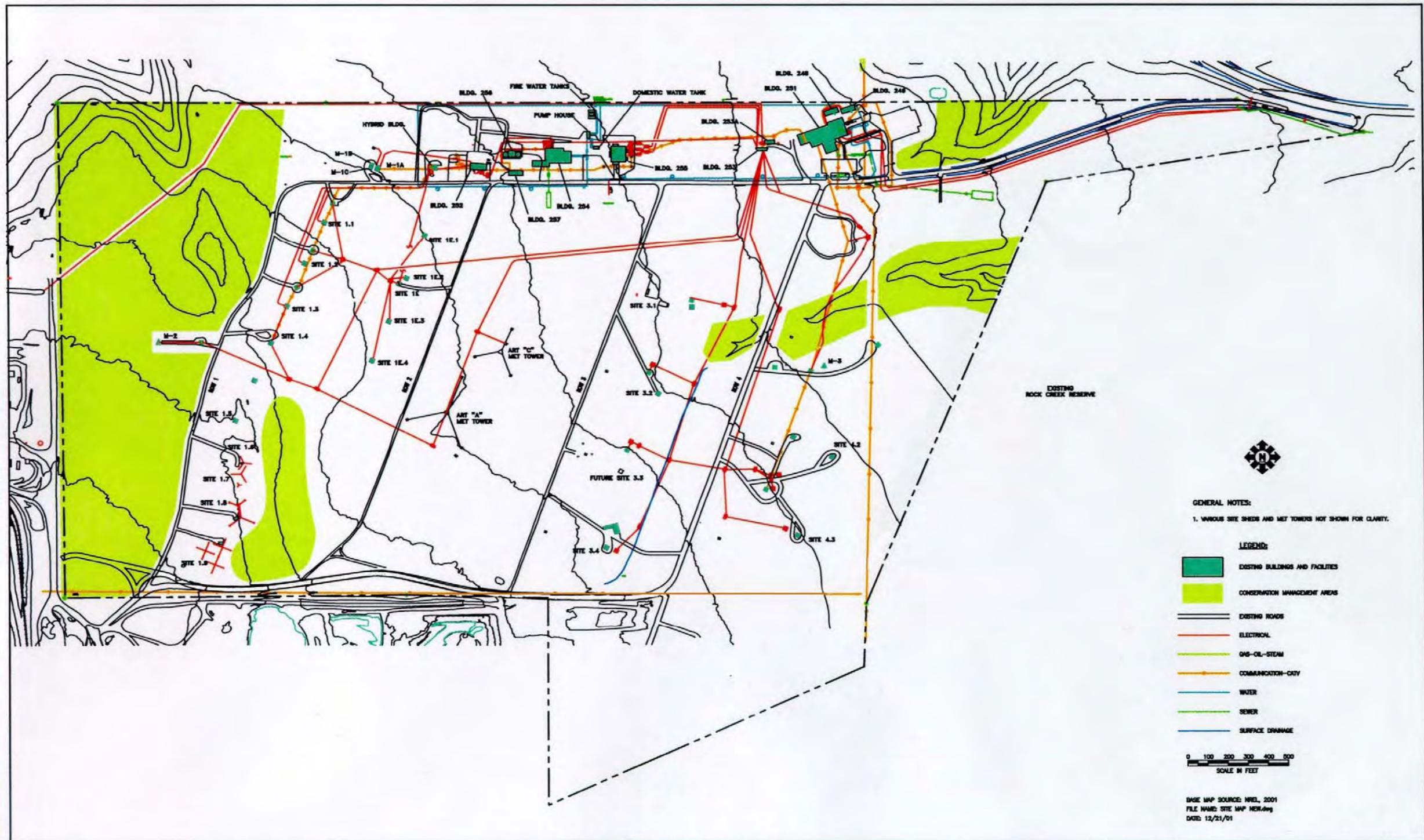


Figure 1-4 Site Map

## Site Environmental Conditions/Features

Photos for each site documenting the site features and development are included at the end of this section. Figures 1.5, 1.6, 1.7 and 1.8 show the South Table Mountain and Denver West Office Park sites, and Figures 1.9 and 1.10 provide images of the National Wind Technology Center site. The views on the STM site also illustrate the Conservation Easement property and the Camp George West property acquired in 1999.

## Climate

The climate for the geographic region of NREL operations is classified as semi-arid, typified by limited precipitation, low relative humidity, abundant sunshine, and large daily and seasonal temperature variations.

The area experiences moderate precipitation, with average annual rainfall less than 50 cm (20 in). Almost half of the annual precipitation occurs from March to June. Summer showers contribute 33% of the annual precipitation total. Precipitation begins to decrease significantly in the fall, and reaches the minimum during winter. Winter is the driest season, contributing less than 10% of the annual precipitation, primarily in the form of snowfall.

Spring is a season of unstable air masses with strong winds along the foothills and the Front Range. The highest average snowfall occurs in March, and the STM site can generally expect to experience at least one heavy snowstorm with totals exceeding 15 to 25 cm (6 to 10 in.).

The solar radiation (sunlight energy) of the region is excellent for outdoor research and testing of solar energy conversion devices and systems. Sunshine is abundant throughout the year and remarkably consistent from month to month and season to season.

### ***1.1 South Table Mountain Site***

#### *Geology, Soils, and Hydrogeology*

The STM site is a roughly triangular parcel of land occupying portions of the top, sides, and lower south-facing slopes of South Table Mountain. South Table Mountain is composed of sedimentary rocks below a basalt lava cap, which is quite resistant to erosion. The South Table Mountain feature is a mesa that stands about 150 meters above the adjacent lowlands. The mesa was formed as weak sedimentary rocks surrounding the lava were eroded away, leaving the lava-capped mesa in relief. Below the lava caprock, the sedimentary rocks are part of the Denver Formation that consists of layers and lenses of claystone, sandstone, and conglomerate. Sedimentary rocks of the Arapahoe Formation underlie the Denver Formation.

Both the Arapahoe and Denver Formations are considered to be aquifers in portions of the Denver Basin. The Denver Formation underlies the areas on which most NREL construction has taken place. Groundwater on the STM site occurs primarily in the

weathered and fractured silts and sands of the Denver Formation. There may also be some groundwater in the form of perched aquifers below the basaltic lava cap on the South Table Mountain and within the materials above the Denver Formation, which are largely the result of stream deposits. Groundwater flow on the site is in a southeasterly direction.

The soil covering the top of South Table Mountain is Lavina Loam. A loam is composed of a mixture of clay, sand, silt, and organic matter. The loam on the mesa top is a shallow, well-drained clayey soil. Soil on the upper side slopes of South Table Mountain is also a loam consisting of extremely stony soils with significant amounts of clay. Much of the remainder of the site, including the area designated for major development, has a deep, well-drained soil referred to as Denver clay loam. It consists of clayey material containing some calcium carbonate. There are also two smaller soil areas on the southwestern portion of the site, both of similar character to other site soils: cobbly clay loam and very stony clay loam.

#### Surface Water

About 90% of the surface drainage off the site, both from the mesa top and across the lower portions of the site, is in the southerly direction toward Lena Gulch (a tributary of Clear Creek). Surface water from two drainage ways on the easternmost portion of the site ultimately flows into Lena Gulch.

There is no permanent stream flow on the STM site. Only occasional flow derived from extended periods of precipitation, usually during the late winter and early spring, is found in the drainage channels with seasonal springs evident along some of the mesa slopes. There is one seep on the mesa top that is often active throughout much of the year, but the water infiltrates and evaporates quickly during the dry season.

#### Vegetation

Two primary vegetation types are present on the STM site: grasslands and shrublands. The most common plant communities on the STM site are mixed grasslands, comprising over 80% of the vegetation on the site. These communities are generally dominated by short- and mid-grass species. Two primary upland shrub communities occur on the STM site: mountain mahogany shrublands, found on the shallow soils of the mesa, and upland shrublands, occurring in drainages lacking active channels as well as drainages with associated wetlands. Recent field surveys have identified limited wetland/riparian areas along drainages. The wetland communities identified on the STM site are a very minor component of the total vegetation cover, accounting for less than 1% of the vegetation over an area of less than 0.3 ha (0.75 ac). Riparian shrub communities also occur adjacent to the emergent wetlands.

#### Wildlife

A wildlife survey was conducted on the site during 1986 and 1987, and additional surveys were done in 1999 over the Conservation easement property. A new survey to update the existing data began in 2004 (see section 5.11 for more detail). Mammals seen using the site during the surveys include mule deer, coyote, gray fox, red fox,

raccoon, long tailed weasel, striped skunk, spotted skunk, badger, bobcat, mountain lion, rabbits, and yellow-bellied marmots. Seventeen species of birds have been observed on the STM site, along with two species of raptors: kestrels and two nesting pairs of red-tailed hawks. NREL personnel have reported numerous sightings of snakes as well as a golden eagle. Amphibian species are known to inhabit the area as well.

### Land Use

The STM site is a 327-acre area predominantly bordered by open grassland zoned for recreation and light-commercial activity. Portions of the community of Pleasant View are located immediately to the south and west of the western portions of the STM site. Pleasant View is currently constructing a recreational park immediately south of the STM site. Offices, shops, and a tree nursery owned by the Colorado State Forest Service are located at the far western edge. Undeveloped state land and a Colorado State Highway Patrol pursuit driver-training track are located along the northwestern boundary of the STM site on top of the mesa. Jefferson County open space wraps around the northern and the eastern edge of the site. Portions of the DWOP and apartment homes lie to the east.

More than half of the STM site (177 acres) has been set aside in a Conservation Easement. No development is allowed on that land, with the exception of some existing utility easements and recreational trails to be established by Jefferson County Open Space. Trail development is planned for implementation in phases by the County, and was begun in 2004. (See Section 6.0 for more detail.)

## ***1.2 National Wind Technology Center***

### Geology, Soils, and Hydrogeology

The NWTC site is located on a plain formed by stream deposits. The uppermost geological layer beneath the site is known as the Rocky Flats Alluvium (RFA). It is composed of cobbles, coarse gravel, sand, and gravelly clay. Below the RFA are the Laramie Formation, Fox Hills Sandstone, and Pierre Shale. These rock formations consist primarily of claystones with some siltstones. Unconfined groundwater flow occurs in the RFA toward the east/southeast, and small perched zones are common. Groundwater occurs as confined aquifers in the deeper bedrock formations (EG&G Rocky Flats, Inc., 1992).

The NWTC has a strongly developed soil defined as a very cobbly, sandy loam. The soil is characterized by a large amount of cobble and gravel in the soil volume, and subsoil dominated by clay (USDA, 1995).

### Surface Water

The area surrounding the NWTC site is drained by five streams: Rock Creek, North Walnut Creek, South Walnut Creek, Woman Creek, and Coal Creek. Rock Creek flows eastward and is located southeast of the NWTC. North Walnut Creek and South Walnut Creek flow eastward into the Great Western Reservoir. Woman Creek drains eastward

into Standley Lake. Coal Creek flows in a northeasterly direction across the City of Boulder open space north of the NWTC.

The majority of the NWTC drains into a tributary to Rock Creek. Some of the northern portions of the site drain into Coal Creek or its tributaries.

### Vegetation

The NWTC is located in the transition area between the Great Plains and the Rocky Mountains (Plantae Consulting Services, 2000). This location results in a flora that contains elements from both mountain and prairie ecosystems and associations that represent residual tall grass prairie, short-grass plains, ponderosa pine woodland, and foothill ravine flora (Plantae Consulting Service, 2000).

A vegetation study conducted between August 1999 and August 2000 identified 271 vascular plant species and defined five major habitat types on the NWTC site including the following: seasonal wetlands/or ephemeral hydric soils, woodlands, shrublands, mixed grasslands, and disturbed areas.

Along the Northwestern ridge is a Ponderosa pine woodland area. Vegetation found in this area includes woody species with an understory of grasses, forbs, and shrubs.

### Wildlife

Prior to 1975, livestock heavily grazed the NWTC site, damaging a majority of the native vegetation. A wildlife survey was conducted in 1992 for the entire Rocky Flats Plant and buffer zone area, including the NWTC site. Signs or tracks of bears and mountain lions were identified. Other mammals known to feed at the site are mule deer, coyotes, desert cottontail rabbits, white-tailed jackrabbits, black-tailed jackrabbits, deer mice, prairie voles, and thirteen-lined ground squirrels. Approximately 20 different species of birds were sighted at or near the site. Raptor (birds of prey) surveys were conducted at the NWTC in 1994 and 1995, and identified seven raptor species on or in the vicinity of the site. An avian survey was also conducted in 2001 to 2002; it is described further in Section 5.10. Although seldom seen, rattlesnakes, bull snakes, racers, and several other reptilian and amphibian species are known to occupy the area.

### Land Use

The NWTC facility occupies a 305-acre area surrounded largely by open space and grazing land. The Rocky Flats Environmental Technology Site borders the NWTC to the southeast, and a sand and gravel mining operation is located along the southern and western boundaries of the site. A blasting company also has a small installation along the western site boundary.

A 25-acre parcel, located at the southeast corner of the NWTC, was recently designated for inclusion within the NWTC by the National Defense Authorization Act (see Figure 1.3). Two test sites and unimproved roads are located on this land. The transfer of this land parcel from DOE Rocky Flats was completed in 2004.

### ***1.3 Denver West Office Park***

The DWOP is a relatively flat, landscaped office complex occupied by a number of four-story buildings, parking lots, and common areas. NREL-leased facilities at DWOP are located approximately in the geographic center of the development. The DWOP is bordered on the south by commercial areas (West Colfax strip), on the west by the Pleasant View residential area, Camp George West facility, and the STM site. DWOP is within the City of Lakewood.

### ***1.4 Joyce Street Facility***

The JSF is located in a commercial area surrounded by agricultural land, residential neighborhoods, and small businesses. It is currently used by NREL as warehouse space only. No research or support activities are currently conducted at the facility, and there are no staff offices at JSF.

### ***1.5 Renewable Fuels and Lubricants Research Laboratory***

The ReFUEL facility is used for research, testing, and support activities related to advanced fuels, engines, and vehicles to objectively evaluate performance, emissions, and energy efficiency impacts. The laboratory will also be used to evaluate and develop heavy hybrid electric vehicles.

The ReFUEL is a small shop complex housed within the RTD/DSOC facility. The RTD/DSOC facility occupies approximately 22 acres of land, serves as the primary maintenance facility for RTD's bus and light rail train systems. The area around the RTD/DSOC facility consists of commercial and light industrial development.

The site lies on relatively flat terrain with a slight gradient to the northwest. The general area is highly developed with concentrated industrial and commercial activities. Very little natural vegetated habitat exists onsite or in the immediate vicinity. There are trees and shrubs lining the South Platte River adjacent to the site's south, east and northeast.

**Figure 1.5** – STM Site – Aerial view looking west, showing facilities at the western end of the site.



**Figure 1.6** – STM Site – View looking west, showing Camp George West acreage acquired in 1999, a portion of the Pleasant View neighborhood, and the Conservation Easement lands.



**Figure 1.7** – STM Site – View looking northwest at the historic amphitheater and the mesa top facilities. The Colorado State Highway Patrol pursuit driver-training facility is located on the right side of the photo.



**Figure 1.8** – STM Site – View looking northwest, over Interstate 70 at the NREL/DOE buildings in the Denver West Office Park.



**Figure 1.9** – NWTC – View looking northwest



**Figure 1.10** – NWTC – View to the northwest with research facilities shown.

